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MFN 06-489
Supplement 8

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U.S. Nuclear Regulatory Commission
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Washington, D.C. 20555-0001

Subject: **Response to Portion of NRC Request for Additional Information Letter No. 148 Related to ESBWR Design Certification Application – Design of Structures, Components, Equipment, and Systems – RAI Number 3.9-160 S02**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) response to a portion of the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) sent by NRC Letter 148 dated February 10, 2008 (Reference 1). The GEH response to RAI Number 3.9-160 S02 is addressed in Enclosure 1.

The GEH response to RAI 3.9-160 was submitted via Reference 3 in partial response to NRC Letter 67 (Reference 2). The GEH response to RAI 3.9-166 S01 was submitted via Reference 5 in response to a request received via email (Chandu Patel) dated June 13, 2007 (Reference 4).

Should you have any questions about the information provided here, please contact me.

Sincerely,

James C. Kinsey

James C. Kinsey
Vice President, ESBWR Licensing

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NRO

References:

1. MFN 08-158, Letter from the U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 148, Related To ESBWR Design Certification Application*, dated February 10, 2008
2. MFN 06-378, Letter from the U.S. Nuclear Regulatory Commission to David H. Hinds, *Request for Additional Information Letter No. 67 Related To ESBWR Design Certification Application*, dated October 10, 2006
3. MFN-06-489, Response to Portion of NRC Request for Additional Information Letter No. 67 *Related to ESBWR Design Certification Application – DCD Section 3.9 – RAI Numbers 3.9-30, 3.9-42, 3.9-82 through 3.9-86, 3.9-88, 3.9-90, 3.9-95, 3.9-120 through 3.9-122, 3.9-152, 3.9-154 through 3.9-156, 3.9-158 through 3.9-160 and 3.9-174*, dated November 30, 2006
4. E-Mail from Chandu Patel (NRC), Supplement 1 to RAI 3.9-160 dated June 13, 2007
5. MFN 06-489 Supplement 7, *Response to portion of NRC Request for Additional Information Related To ESBWR Design Certification Application - Acceptance Criteria for the Design and Qualification of the Gravity Driven Cooling System Squib Valves - RAI 3.9-160 S01*, dated January 7, 2008

Enclosure:

1. Response to Portion of NRC Request for Additional Information Letter No. 148 Related to ESBWR Design Certification Application – GDCS Squib Valves – RAI Number 3.9-160 S02

cc:

AE Cubbage	USNRC (with enclosure)
RE Brown	GEH/Wilmington (with enclosure)
DH Hinds	GEH/Wilmington (with enclosure)
GB Stramback	GEH/San Jose (with enclosure)
eDRF	0000-0081-8753, Revision 2

Enclosure 1

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Response to Portion of NRC Request for

Additional Information Letter No. 148

Related to ESBWR Design Certification Application

GDCS Squib Valves

RAI Number 3.9-160 S02

For historical purposes, the original text of RAI 3.9-160 and the GE response is included. The responses do not include any attachments or DCD mark-ups.

NRC RAI 3.9-160

Describe the method for functional design and qualification including acceptance criteria for demonstrating that the squib valves will perform their function for a range of system pressure, pressure differential, temperature and ambient conditions from normal operating up to design basis conditions.

GE Response

Manufacturer before delivery to site will conduct mechanical testing of GDCS squib valves. Testing will include a full range of pressures and temperatures from ambient conditions to design-basis conditions. The GDCS squib valves will have a piston of sufficient length to drive the valve open. Opening stroke will be guided by guide ribs or other feature to provide an unobstructed flow path. See DCD Tier 2 Revision 2, Subsection 6.3.4.1.

DCD Impact

No DCD changes will be made in response to this RAI.

NRC RAI 3.9-160 S01

Comment on response to RAI 3.9-160 (MFN 06-489):
The applicant is requested to specify the acceptance criteria for the design and qualification of the gravity driven cooling system squib valves.

GEH Response

DCD Tier 2 discusses generic requirements for valve design and qualification (see Sections 3.9, 3.10 and 3.11). Additional requirements for the GDCS squib valves will be added to the DCD as shown in the DCD Impact section below. Detailed design requirements for these valves (e.g., pressures, flows and temperatures) will be specified in a valve specification (either specific to the GDCS squib valves or generic to the ESBWR) and in the purchase order. The vendor will be required to demonstrate that the valves are capable of performing their required functions under the conditions specified in the valve specification and/or purchase order.

DCD Impact

DCD Tier 2, Section 6.3.2.7.2 will be revised as shown in the attached mark-up.

NRC RAI 3.9-160 S02

NRC Summary:

Gravity driven cooling system (GDCS) squib valves

NRC Full Text:

In its response to RAI 3.9-160 S01 (MFN 06-489, Supplement 7, dated January 7, 2008), GEH provides proposed requirements for the GDCS squib valves and deluge (squib-actuated) valves to be included in Section 6.3.2.7.2 in the ESBWR DCD, Tier 2 when Revision 5 is prepared. The staff requests that GEH provide the following information:

a. *Please provide or identify the ITAAC that will be used for verification that the squib valves meet their design requirement.*

b. *Is a qualification report available for NRC review on the GDCS squib and deluge valves (and this type of valve in other systems) similar to the report for the depressurization valves (DPVs)?*

c. *Does operating experience from current nuclear power plants exist for the designs and sizes of squib-type valves to be used in the ESBWR?*

d *Discuss the operation of the squib valve that ensures that the flow path is not inadvertently blocked by the ram or other valve internals following actuation.*

e. *Regarding the proposed design requirement of zero leakage specified for the deluge valve in the event of "inadvertent" opening of the GDCS injection squib valve, is this requirement also applicable to any opening of the GDCS injection squib valve?*

GEH Response

a. DCD, Tier 1, Table 2.4.2-3 includes the following ITAACs for the GDCS system.
   - ITAAC 9: "The GDCS squib valve used in the injection and equalization open as designed."
   - ITAAC 22: "The GDCS Deluge squib valves open as designed."
   - ITAAC 12: "GDCS squib valves maintain RPV backflow leak tightness and maintain reactor coolant pressure boundary integrity during normal plant operation."

b. Qualification programs for squib valves other than the DPVs have not yet been completed; therefore, there are no other qualification reports available for review by the NRC.

c. There is experience with squib valves in the Standby Liquid Control (SLC) system injection valve application in existing BWR plants, although the ESBWR SLC valves will be larger. Based on a review of operating experience (OE) with these valves, there have been failures (e.g., failure to open and inadvertent opening); however, the issues were generally caused by problems with the control system or human performance errors. No generic issues with the squib valve design were identified in the OE. There is no operating experience with the GDCS or DPV squib valve designs from current nuclear plants.

d. Specific valve designs have not yet been selected and qualified for most ESBWR safety-related applications, including the GDCS injection and deluge squib valves. DCD Revision 4, Figure 6.3-2 is a figure of a typical squib valve that was thought to meet the requirements for the GDCS squib valves. However, after further evaluation, this design may not be able to meet GDCS squib valve requirements because, as suggested in paragraph d of this RAI supplement, the piston may block flow and/or the shear cap may not fully clear the flow stream following valve actuation. Accordingly, this figure will be removed from the DCD.

   The GDCS squib valves will be functionally qualified to perform their required functions and meet all design requirements as discussed in section 3.9.3.5 of the DCD. GEH's response to Supplement 1 of this RAI added to the DCD design requirements related to minimum flow coefficient for the GDCS injection and deluge valves. Qualification of the designs selected for these applications will ensure these flow coefficient requirements are met and therefore that neither the piston nor the shear cap (or disk) will inadvertently block the flow path.

e. The GDCS deluge valves will be designed to remain closed with zero leakage under all normal operating and design basis conditions, during anticipated operational occurrences, and following the inadvertent opening of a GDCS injection line squib valve while the RPV is at normal operating pressure. The DCD will be revised accordingly.

DCD Impact

DCD Tier #2, Section 6.3.2.7.2 and Figure 6.3-2 will be revised in Revision 5 as shown in the attached markup.

temperature greater than setpoint in any two adjacent cells, initiates deluge line flow. Inadvertent actuation is prevented by the presence of an inhibit signal if another set of dedicated safety-related thermocouples monitoring the lower drywell temperature do not sense the temperature to be greater than a preset value. The initiation signal opens the deluge valve on each separate deluge line to allow GDCS pool water to drain to the lower drywell. This water aids in cooling the molten core.

Equipment and Component Description

The following describes the GDCS squib valve, deluge valve and biased-open check valve, which are unique system components that are not used in previous BWR designs.

Squib Valve

The function of the squib valve is to open upon an externally applied signal and to remain in its full open position without any continuing external power source in order to admit reactor coolant makeup into the reactor pressure vessel in the event of a LOCA. The valves also function in the closed position to maintain RPV backflow leaktight and maintain reactor coolant pressure boundary during normal plant operation. The GDCS squib valves have a C_v that will permit development of full GDCS flow. The valve is a horizontally mounted, straight through, long duration submersible, pyrotechnic actuated, non-reclosing valve with metal diaphragm seals and flanged ends. The valve design is such that no leakage is possible across the diaphragm seals throughout the 60-year life of the valve. The squib valve is classified as Quality Group A, Seismic Category I, and ASME Section III Class 1. The valve diaphragm forms part of the reactor pressure boundary and as such is designed for RPV service level conditions.

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~~Illustrated in Figure 6.3-2 is a typical squib valve design that satisfies GDCS system requirements. This valve has similar design features to the ADS depressurization valve.~~

Valve actuation initiates upon the actuation of either of two squib valve initiators, a pyrotechnic booster charge is ignited, and hot gasses are produced. To minimize the probability of common mode failure, the injection line squib valve pyrotechnic booster charge is from a different batch than from the batch used in equalizing line squib valves. ~~When these gasses reach a designed pressure, a tension bolt holding a piston breaks allowing the piston to travel downward until it impacts the ram and nipple shear caps. Once the piston impacts the ram and nipple shear caps, the nipples are sheared. The ram and shear caps are then driven forward and are locked in place at the end of stroke by an interference fit with the nipple retainer. This lock ensures that the nipples cannot block the flow stream and provides a simple means of refurbishment by simply unthreading the plug. A switch located on the bottom of the valve provides a method of indication to the control room of an actuated valve. The shear nipple sections are designed to produce clean shear planes.~~

~~The piston is allowed to backup after shearing the nipples. Standard metal seals are installed on the piston to reduce the potential of ballistic products from entering the flow stream.~~

~~The squib valve can be completely refurbished once fired. The squib valve housing, nipples, adapter flanges, actuator housing, indicator switch body, indicator plunger, head cap, coupling, collar and adapter are machined. The piston, ram, and tension bolt are made from heat treated material for necessary strength.~~

The squib valve will be designed to meet the following requirements:

- The valve shall be designed such that, in the event of squib actuation, no internal fragments (not inherently trapped within the valve) are produced of a size that if transported downstream could, by themselves or collectively, credibly represent a threat of blockage at the venturi throat.
- The valve shall be designed such that, in the event of squib actuation, no missiles are generated that could impact the operation of any system valves, components or instrumentation within the drywell.
- The valve shall provide remote indication of "valve opened" and "valve closed" status.
- The valve shall have a C_v greater than 1095 gpm/psi$^{1/2}$ at full GDCS flow. The valve manufacturer shall perform a full flow test and provide test data to verify the minimum required C_v.
- Once the valve is open, it shall remain permanently open.

GDCS Check Valve

The GDCS check valves are designed and installed such that the ~~check~~ valves ~~is~~ are fully open ~~when~~ with zero differential pressure ~~is applied~~ across the ~~check~~ valve and fully closed with a low reverse differential pressure to prevent back flow. ~~The full open position is accomplished by valve design and installation.~~ The check valve is a long duration submersible, piston check valve (of suitable pattern such as Y-pattern or axial flow) installed in a horizontal or vertical piping run. The valve meets the requirements for minimum fully open flow coefficient in the forward flow direction and maximum fully open flow coefficient in the reverse flow direction. The reverse flow coefficient addresses the case in which a check ~~requirements for a~~ valve sticks in the fully open position following a LOCA. Type testing is performed to verify the valve meets the reverse flow coefficient requirement. The results of the testing and a comparison of the measured flow coefficient to the maximum value will be documented in a report. The check valve is classified as Quality Group A, Seismic Category I, and ASME Section III Class 1.

Remote check valve position indication is provided in the main control room by position-indication instrumentation.

Deluge Valve

The deluge valve is a 50 mm (2 inch) squib valve similar in design to the SLC squib valves or ADS depressurization valves. To minimize the probability of common mode failure, the deluge valve pyrotechnic booster material is different from the booster material in the other GDCS squib valves. The pyrotechnic charge for the deluge valve is qualified for the severe accident environment in which it must operate.

The deluge valve will be designed to meet the following requirements:

- The valve shall remain closed with zero leakage under all normal operating and design basis conditions, during anticipated operational occurrences and following the inadvertent opening of a GDCS injection line squib valve while the RPV is at normal operating pressure.

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- The valve shall be designed to survive the severe accident environment and still perform its intended function.

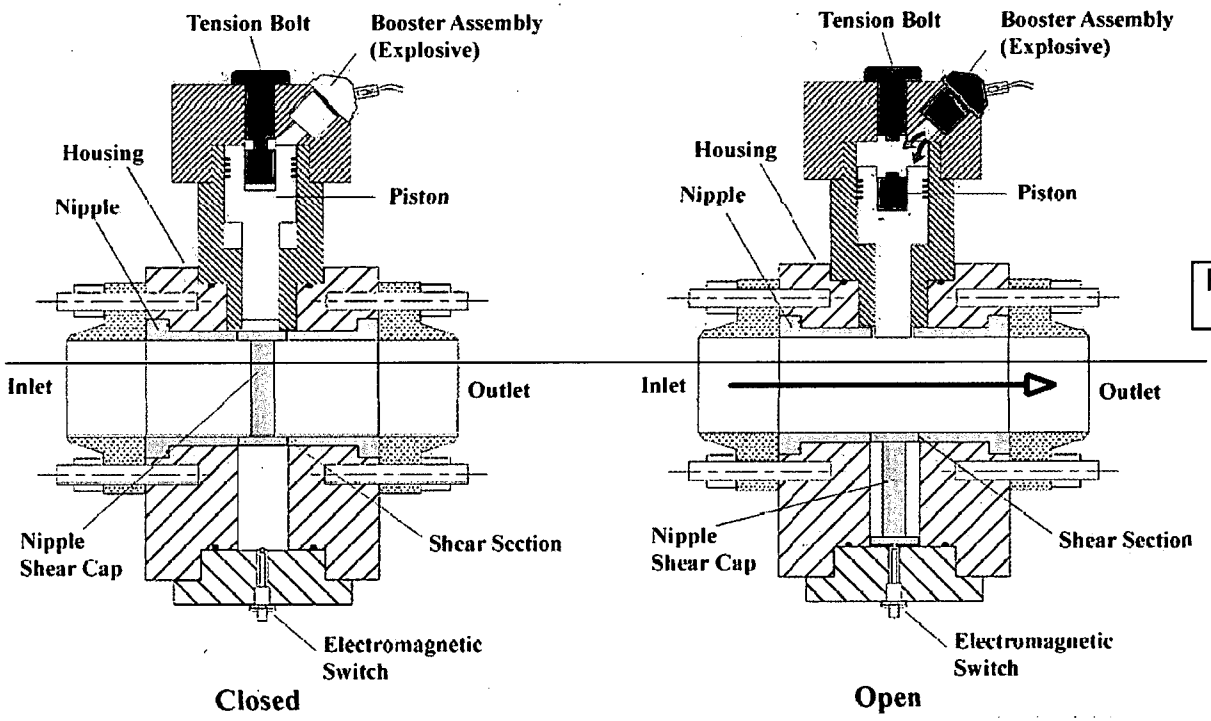

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Figure 6.3-2. (Deleted)~~Typical GDCS Squib Valve~~